minow has made an extended series of experiments on this subject. Exner had already noticed (*Pflüger's Archiv*, Vol. XXXII) that the periphery is more sensitive to change of brightness than the center, and that it has a special tendency to interpret change of brightness as due to motion. Hence it detects small motions more readily. Bellarminow regulated the intensity of the light by the width of a slit, produced intermittance by a rotating disk, determined the velocity of its rotation by the pitch of its musical note, and used the spectrum for experiments in color. In a faint light the rapidity of rotation necessary to cause flickering to cease was only two-thirds as great at the center as in the periphery. In strong light the difference was not so great. Blue and violet gave the same results as white light, but green, and still more yellow, fused at high intensities soonest in the periphery. The size and shape of the object looked at seemed to have no effect on the result. The author attributes these results to the greater intensity but shorter duration of after-images in the periphery. He does not make it plain how that, if it were true, would be an explanation. Nor does he give anything to show that the greater sensitiveness of the periphery is not a quality of cortical instead of retinal vision. It might well be that we had the habit of giving such instantaneous and undivided attention to indications of motion in the lateral field of vision as would be quite sufficient to account for a greater power of detecting it. There is at present, of course, no sure way of distinguishing between the retinal and the cortical divisions of the visual process.

C. L. F.

Physiologische Studien über die Orientirung, unter Zugrundelegung von Yves Delage Etudes expérimentales sur les Illusions statiques et dynamiques de Direction pour servir à déterminer les Fonctions des Canaux demicirculaires de l'Oreille interne. HERMANN AUBERT. Tübingen, 1888, pp. 122.

The fact that nearly all the other works on the subject of the functions of the semi-circular canals were either written in German or have already been translated into German (the brief papers of Laborde and Crum Brown form the only exception) has induced Aubert to translate this work of Delage's, which appeared originally in the *Archives de Zoologie expérimentale*, 1886 (see review in this JOURNAL, Vol. I, p. 179). He takes occasion to add many foot-notes of his own, chiefly confirmatory of Delage, in view of the fact that his own complete investigations on the subject will not be ready for publication for some years to come.

Since Delage's articles were written, the question whether the semi-circular canals are or are not organs for the perception of rotation has been set at rest by the admirable work of Breuer in producing determinate rotations of the head in doves by electrical stimulation. (See Pflüger's Archiv, Bd. 34, p. 135, reviewed in this JOURNAL, Vol. II, p. 332.) But in what way the sensation is excited still remains an unsettled question. Breuer produces the compensatory motions of the head (and hence, by inference, the sensations) by drawing out the endolymph with a piece of blotting-paper, but this does not prove that an actual motion of the endolymph must take place every time that the sensation is produced. A retarded flow of liquid in large glass tubes made in the shape of the canals takes place in a way that would exactly explain all the phenomena, but most writers

agree (and Mach has shown by experiment) that that retardation would not take place in tubes so small as the actual canals, and hence there is nothing but changes of pressure to fall back upon. Aubert does not obtain the same experimental results as Delage when it is a question of throwing doubt upon the sufficiency of this explanation, and Mach maintains that the change of pressure which would take place is not too inconsiderable to produce the required effect (*Bewegungsempfindungen*, Leipzig, 1875). The work done in hearing the lowest perceptible sounds, according to Töpler and Boltzman, is 1 : 3,000,000,000 of a kilogrammeter per second; in seeing the faintest lights, it is, according to Thomson, 1 : 5,740,000,000; and Mach's calculations show that much more than that would be done in the semi-circular canals. C. L. F.

Zur Physiologie der Bogengänge. J. Rich. Ewald. Pflüger's Archiv, Bd. XLIV, H. 7–8–9.

On opening the bony semi-circular canals of a dove, variations in the level of the perilymph are sometimes to be observed, which have been connected by some observers with the rhythm of the heart. It seemed to Ewald at first that they rather followed respiration, but he later discovered that they were produced by the movements of the lower mandible, which sometimes accompany respiration, and occasionally for a few seconds are as rapid as the pulse. The mandible moves the adjacent parts of the skin, and they the ear-drum, which communicates the motion indirectly to the perilymph. In uninjured canals the changes in the level must be changes of pressure, affecting both perilymph and endolymph, but do not cause sensations of rotation, because the pressure is equal in all the ampullae. The impulses are too few and too gentle to cause sensations of tone or noise, but probably do cause momentary deafness, as yawning does in man.

Bydrage tot de physiologie van den reuk. H. Zwaardemaker. Feestbundel van Donders, 1888, p. 179. Abstract by Heymans, Centralblatt f. Physiol. No. 26, 1889.

Using yellow wax to produce an olfactory stimulus, the author found that 0.1 second elapsed before the odor from a surface of 122 sq. mm. held before the nose was perceived. With smaller surfaces the time was longer (though not shorter with larger ones), and warming the wax quickened its perception. He found also that different odors diffuse themselves in still air at different rates. At a distance of 40 cm. and a temperature of 15° acetic ether was perceived in 4 seconds, sulphuric ether in 9, soap and tallow in 10, paraffine in 18, camphor in 19, yellow wax in 20, turpentine in 22, vulcanized rubber in 45, thus forming a series according to rate of diffusion from the most to the least volatile, the rate depending on the physical peculiarities of the molecules. The author has devised an instrument with which to test the sense of smell, depending on the relation of the area of the exposed surface of the odorous substance to the intensity of the odor. Individuals differ as to acuteness, but for the same person and the same substance the acuteness is constant. The author considers the olfactory stimulus to be a chemico-mechanical one.